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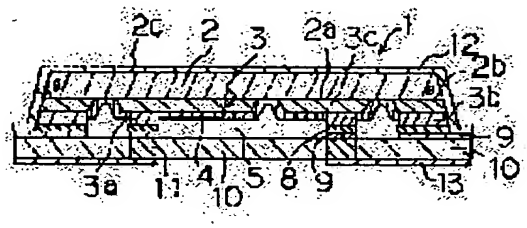
(71)Applicant : KYOCERA CORP
(72)Inventor : YAMAGATA YOSHIFUMI
FUNEMI MASAYUKI

(54) SURFACE ACOUSTIC WAVE DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To miniaturize a device to the utmost, without damaging the attenuation characteristic by forming one side of a piezoelectric substrate to be acute with respect to a circuit board and making protective films adhere to the other main face side and the side of the piezoelectric substrate.
SOLUTION: In a chip surface acoustic wave filter 1, an electrode 3 of an excitation electrode is formed on an under face 2a of a piezoelectric substrate 2 of lithium tetraborate single crystal. Namely, plural comb-like resonance electrodes 3c being excitation electrodes are connected in a ladder-like circuit in the under face 2a of the piezoelectric substrates 2 and the semiconductor or insulating electrode protection film 4 of silicon and silicon oxide is formed on a connection electrode 3d, an input/output electrode 3a and a ground electrode 3b. A metallic bar 12, being a conductive protection film is bonded/formed on an upper face 2c and a side 2b of the piezoelectric substrate 2. In order to uniformly form a vapor deposition material on the side face 2b of the piezoelectric substrate 2, it is best to set an angle (taper angle) that the under face 2a and the side 2b of the piezoelectric substrate 2 form to be 45 to 80 degrees.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] Surface acoustic wave equipment which is surface acoustic wave equipment which was made to mount the inferior-surface-of-tongue side of the piezo-electric substrate in which the excitation electrode was formed, on the circuit board, and is characterized by carrying out covering formation of the protective coat on the top face and side face of this piezo-electric substrate while forming the side face of said piezo-electric substrate in an acute angle to an inferior surface of tongue.
[Claim 2] Surface acoustic wave equipment according to claim 1 characterized by forming the side face of said piezo-electric substrate in 45 degrees - 80 degrees to an inferior surface of tongue.
[Claim 3] Surface acoustic wave equipment according to claim 1 characterized by said protective coat being conductivity.

[Translation done.]

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(71)出願人　000006633
京セラ株式会社
京都府京都市伏見区竹田鳥羽殿町6番地

(72)発明者　山形　佳史
京都府相楽郡精華町光台3丁目5番地　京セラ株式会社中央研究所内

(72)発明者　船見　雅之
京都府相楽郡精華町光台3丁目5番地　京セラ株式会社中央研究所内

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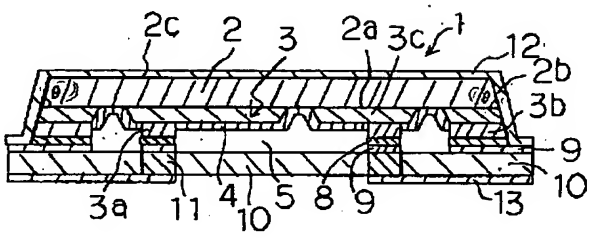
(54)【発明の名称】弾性表面波装置

(57)【要約】
【課題】　減衰特性を損なわずに、究極的に小型化が可能で信頼性の優れた弾性表面波装置を提供すること。
【解決手段】　励振電極を形成した圧電基板２の一主面側を下側にして回路基板上に実装するようにした弾性表面波装置１であって、圧電基板２の側面が下面に対して鋭角に形成されているとともに、圧電基板２の他主面側及び側面に保護膜１２が被着されていることを特徴とする。



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【特許請求の範囲】

【請求項１】　励振電極を形成した圧電基板の下面側を回路基板上に実装するようにした弾性表面波装置であって、前記圧電基板の側面を下面に対し鋭角に形成するとともに、該圧電基板の上面及び側面に保護膜を被着形成したことを特徴とする弾性表面波装置。

【請求項２】　前記圧電基板の側面を下面に対して４５°～８０°に形成したことを特徴とする請求項１に記載の弾性表面波装置。

【請求項３】　前記保護膜が導電性であることを特徴とする請求項１に記載の弾性表面波装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、例えば携帯電話等の移動体通信機器に用いられ、弾性表面波フィルタやデュプレクサ等の弾性表面波装置に関する。

【０００２】

【従来技術とその課題】現在、移動体通信機器に用いられる弾性表面波フィルタは、激化する携帯電話端末の小型化のために、極限までに低実装面積で低重量且つ低背であることが望まれている。

【０００３】従来、図９（ａ）～（ｃ）に示す弾性表面波フィルタＪ１は、主として励振電極が形成された圧電性の単結晶から成る基板１０２と、それを封止実装するセラミックパッケージ１０８から成る。

【０００４】基板１０２には、アルミニウムやアルミニウム－銅合金等から成る櫛歯状の弾性表面波共振子電極（励振電極）１０３、入出力電極１１３ａ，１１３ｂとグランド電極（図示せず）、及びそれらの接続電極が同一面に形成されている。

【０００５】励振電極１０３には、その上面に保護膜１０４が形成されており、ごみなどの異物の付着や腐食を防止している。基板１０２は樹脂１１０によりセラミックパッケージ１０８の底部に固定され、基板１０２上の入出力電極１０３ａとグランド電極（図示せず）が、セラミックパッケージ１０８の入出力端子電極１１３ａ，１１３ｂへ、それぞれワイヤー１１４を用いて導通接続されている。

【０００６】ワイヤー１１４を接続する部分には、接続の安定性確保のため保護膜は形成されない。基板１０２は弾性体であるので、自由振動を確保する空間１０５が必要である。このため、上部にリッド１０９が設けられ、外部から水分や湿気が入ることによる振動ダンピングを防止するように、セラミックパッケージ１０８と樹脂１１０により気密封止されている。特に、水分等の浸入は圧電基板が四ホウ酸リチウム単結晶等の場合には潮解性があるので信頼性等の点で深刻な問題となる。

【０００７】このような弾性表面波フィルタにおいては、基板１０２とセラミックパッケージ１０８との電気的接続をワイヤー１１４により行っており、この分の高

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さが小型化の妨げとなっていた。また、セラミックパッケージ１０８は基板１０２に比べ非常に大きく、例えば１辺当たり約１．５～２．１ｍｍも大型化し、底面積にいたっては約３倍にもなっていた。

【０００８】さらに、図９（ａ）に示すように、セラミックパッケージ１０８内部のグランド端子電極１１３ｂが、幅の狭い端面グランド電極を介して、図９（ｃ）に示すように、セラミックパッケージ１０８の裏面に接続されているためインダクタ成分が発生しており、図１０に円部で示すように、通過帯域（ハッチング部分）の低周波側、及び４～６ＧＨｚにおける減衰特性が劣化していた。

【０００９】また、図１１（ａ）～（ｃ）に示すような弾性表面波フィルタＪ２は、基板１０２上の入出力電極１０３ａとグランド電極（図示せず）とを、金属製のバンプ１１１を介してセラミックパッケージ１０８上の端子電極１１３ａ，１１３ｂへ接続し、バンプ１１１と端子電極１１３ａ，１１３ｂとの接続強度の低さを補うため導電性の樹脂１１２により補強を行っている。また、導電性樹脂１１２はバンプ１１１の平坦度の悪さを吸収する役目も担っている。以上の構造により、ワイヤーのループ高さの分だけ低背化を図ることができる。

【００１０】しかしながら、セラミックパッケージ１０８の底面積が小型になることにより裏面の入出力端子電極１１３ａの間隔ｇが狭くなり、この電極間に容量が発生している。このため、図１２に円部で示すように、通過帯域（ハッチング部分）の高周波側、及び３ＧＨｚ近傍の減衰特性が劣化していた。また、依然としてセラミックパッケージ１０８がフィルタ形状の大部分を占め、小型，軽量，低背化の妨げとなっていた。

【００１１】そこで本発明は、減衰特性を損なわずに、究極的に小型化が可能で信頼性の優れた弾性表面波装置を提供することを目的とする。

【００１２】

【課題を解決するための手段】上記課題を解決するために、本発明の弾性表面波装置は、励振電極を形成した圧電基板の一主面側を下側にして回路基板上に実装するようにした弾性表面波装置であって、圧電基板の側面が前記回路基板に対して鋭角に形成されているとともに、該圧電基板の他主面側及び側面に保護膜が被着されていることを特徴とする。また好適には圧電基板の側面が回路基板に対して４５°～８０°に形成するとよく、さらに、保護膜が金属等の導電性膜で構成すれば外濫電波（高調波等）を好適にシールドすることができる。

【００１３】

【発明の実施の形態】以下に、本発明に係る弾性表面波装置の実施形態について図面に基づいて詳細に説明する。

【００１４】図１に弾性表面波装置として弾性表面波フィルタ１の実装構造の断面図を、図２にその電極構造を

示す。弾性表面波フィルタ１は、例えばタンタル酸リチウム単結晶、ランガサイト型結晶構造を有する単結晶（例えば、ランタンーガリウムーニオブ系単結晶）、四ホウ酸リチウム単結晶等の圧電基板２の下面２ａに励振電極等の電極３が形成されている。すなわち、圧電基板２の下面２ａに、後記する励振電極である櫛歯状の共振子電極３ｃの複数が、例えばラダー型回路に接続されており、その接続電極３ｄ，入出力電極３ａ，接地用電極３ｂの上に、シリコンや酸化シリコン等の半導電性または絶縁性の電極保護膜４が形成されている。また、圧電基板２の上面２ｃ及び側面２ｂには、導電性の保護膜である金属薄膜１２が薄膜形成法により被着形成され、耐候性に富む構造のチップ弾性表面波フィルタを実現している。

【００１５】ここで、圧電基板２の上面及び側面に形成する保護膜は、外濫電波（高調波等）をシールドするために、導電性であることが望ましいが、さらに気密性を確保することができ、成膜を簡便且つ容易にする上で金属とするのがよい。金属薄膜１２を形成するに当たり、チップ弾性表面波フィルタを個々にダイシングにて切り離しを行った後、蒸着法によりＡｌ，Ａｕ，Ｔｉ，Ｃｒ等から成る１種以上の金属を成膜するかＡｌ膜とＣｕ膜との積層構造，Ｗ膜とＡｕ膜の積層構造等を形成する。

【００１６】ダイシングで切り離した圧電基板２の側面にも、金属薄膜１２を適度な厚みで構成させる必要があるが、この成膜は蒸着法で行うのが最も簡便である。このとき、蒸着粒子は被蒸着面へほぼ垂直方向に成膜されるため、圧電基板２の側面が垂直の場合は均一な成膜が困難である。

【００１７】そこで、本発明ではチップ弾性表面波フィルタを個々にダイシングにて切り離す際に、ダイシングの歯の形状が凸状（例えばＶ字状）のものを用い、素子端部にテーパを形成しながら切り離す。そして、圧電基板２の上面と側面に膜厚５００Å～１０μｍの金属薄膜１２を形成する。ここで、膜厚を上記範囲にしたのは、５００Å未満とすると圧電基板２の側面や上面端部等において成膜が困難となり耐候性に信頼が保てず、１０μｍを超えると金属薄膜１２と圧電基板２の線膨張係数の差により低温で圧縮応力、または高温で引っ張り応力が発生し温度特性に悪影響を及ぼすからである。

【００１８】また、図１及び図６（ｌ）で明示した圧電基板２の下面２ａと側面２ｂとの成す角度（テーパ角）θは、４５～８０度が最良である。この理由は、テーパ角が８０度を超えると蒸着材が圧電基板２の側面に均一に成膜されない。また、テーパ角が４５度未満であれば圧電基板２の側面が鋭利になり、チップを載置する際、圧電基板２に割れやカケが発生し、弾性表面波の伝搬に悪影響を及ぼすからである。

【００１９】上記のようにして構成した弾性表面波フィルタ１は、圧電基板２の下面側もしくは側面に、共振子電極３ｃを取り囲む接地用電極３ｂを形成して回路基板６上に実装する。そして、回路基板６の表面と共振子電極３ｃの表面との間ｈが、弾性表面波の波長以上の距離に設定されている。

【００２０】なお、図１において８は導電性樹脂等から成る導電性の接着材であり、９はフィルタ基板１０上に形成した金属等から成る接続パッドであり、１１はビア電極、１３は外部取り出し電極である。そして、このように構成された弾性表面波フィルタ１を外部回路基板に実装するようにする。また、図３に示すように、図１のフィルタ基板１０の代わりに、直接、ガラスエポキシ等から成る回路基板６に、圧電基板２の下面２ａ側をフェースダウン実装するようにした弾性表面波フィルタ１'（フィルタ基板１０の代わりに回路基板６を用いた以外は弾性表面波フィルタ１と構成は同様）を構成してもよい。

【００２１】ここで、入出力電極３ａと接地用電極３ｂは同一プロセスにて形成されているので、これらの電極は平坦度に優れている。また、半導電性または絶縁性から成る電極保護膜４よりも入出力電極と接地用電極が突出しているので、自由振動のための空間５を保つことができ、このままフィルタ基板１０若しくは回路基板６へフェースダウンで実装することが可能である。また、接地用電極３ｂが基板２の全周囲に形成されているので気密性も確保される。

【００２２】また、チップ弾性表面波フィルタの圧電基板の上面及び側面に金属薄膜を形成しているので、ＲＦ（Ｒａｄｉｏ　Ｆｒｅｑｕｅｎｃｙ）ブロックでの不要な電磁波の遮断が可能である。

【００２３】なお、本発明ではラダー型フィルタについて説明したが、共振器型や伝搬型のフィルタやフィルタ以外のデュプレクサ等の弾性表面波装置についても、励振電極を有するものであればよく、本発明の要旨を逸脱しない範囲で適宜変更し実施が可能である。

【００２４】

【実施例】以下、本発明に係るチップ弾性表面波フィルタを作製した具体的実施例について説明する。

【００２５】図５（ａ）～（ｈ）、及び図６（ｉ）～（ｍ）は、それぞれチップ弾性表面波フィルタの製造プロセスを示す模式的な断面図である。なお、製造にはステッパー（縮小投影露光機）及びＲＩＥ（Reactive Ion Etching）装置を用いフォトリソグラフィーを行った。

【００２６】（１）まず、基板２（タンタル酸リチウム単結晶の４２°Ｙカット）をアセトン・ＩＰＡ等を使用して超音波洗浄を施し、有機成分の除去を行った。次に、クリーンオーブンによって充分に基板乾燥を行った後、図５（ａ）に示すように、電極３の成膜を行った。電極３の成膜にはスパッタリング装置を使用し、Ａｌ－Ｃｕ（２重量％）合金から成る電極３を成膜した。この電極膜厚は約２０００Åとした。

【００２７】（２）図５（ｂ）に示すように、フォトレジスト７を約０．５μｍの厚みにスピンコートにより塗布した。

【００２８】（３）図５（ｃ）に示すように、ステッパーにより所望形状にパターンニングを行い、現像装置にて不要部分のフォトレジスト７をアルカリ現像液で溶解させ、所望レジストパターンを形成した。

【００２９】（４）図５（ｄ）に示すように、ＲＩＥ装置により電極３を所望パターンにエッチングを行った。

【００３０】（５）図５（ｅ）に示すように、フォトレジスト７を剥離しパターンニングを終了した。

【００３１】（６）図５（ｆ）に示すように、SiO_2から成る電極保護膜４をスパッタリング装置にて２５０Åの厚みに成膜した。

【００３２】（７）図５（ｇ）に示すように、フォトレジスト７を厚み約３μｍで全面に再度塗布した。

【００３３】（８）図５（ｈ）に示すように、入出力電極３ａ及び接地用電極３ｂを形成する基板２のフォトレジスト７の一部を感光させ削除した。

【００３４】（９）図６（ｉ）に示すように、入出力電極３ａと接地用電極３ｂを形成する基板２のSiO_2電極保護膜４をＣＤＥにより除去した。

【００３５】（１０）図６（ｊ）に示すように、Ａｌ電極を電極保護膜４よりも厚くなるよう２μｍの厚みに蒸着法により成膜した。

【００３６】（１１）図６（ｋ）に示すように、フォトレジスト７とともにフォトレジスト上の電極材料をリフトオフにより除去した。。

【００３７】（１２）図６（ｌ）に示すように、ウエハをダイシングラインに沿ってＶ字型の歯を用いてダイシングし、チップ端部のテーパ角θが４５°～８０°となるように分割しチップを完成させた。

【００３８】次に、実装について説明する。

【００３９】（１３）図６（ｍ）に示すように、上記チップをフィルタ基板１０にフェースダウン実装し、入出力電極３ａとグランド電極３ｂを基板上の電極とを導電性樹脂（図示せず）により接続した。

【００４０】（１４）図１に示すように、圧電基板２の上面２ｃ及び側面２ｂにＡｌを蒸着により厚み１０００Å形成した。

【００４１】（１５）最後に、フィルタ基板１０をチップに合わせてダイシングにより個片に分割して個々のフィルタ１を完成させた。

【００４２】上記の実装には、接地用電極３ｂの外周及び入出力電極部に、銀フィラーを９０～９３重量％、又は８１～８６重量％含有させた、反応性ポリエステル系樹脂又はエポキシ系樹脂をスクリーン印刷法にて塗布し、一旦、８０℃，１時間程度の仮硬化を行い、次いで、１２０～２２５℃，１０～６０分で硬化させて実装を行った。

【００４３】上記弾性表面波フィルタの実装構造によれば、金属材により圧電基板外周部を取り囲んでおり、また基板２の周囲を接地用電極３ｂで取り囲こむようにしているので、気密性も同時に確保できた。また、入出力電極３ａと接地用電極３ｂは同一プロセスにて形成されているので、平坦度に優れており導通信頼性を極めて高くすることができる。また、空間５の高さは２μｍ程度に確保されており、この高さは弾性表面波フィルタの中心周波数における波長とほぼ同等であり、これ以上の空間高さがあれば弾性表面波の振動を妨げることがない。

【００４４】このようにして得られたチップ弾性表面波フィルタの電気特性は、図３に示すように、従来生じていた減衰特性の劣化が無く、良好な減衰特性を得ることができた。また、通過帯域（ハッチング部分）よりも高周波側では２０ｄＢ以上の減衰量を得ることができ、しかも通過帯域近傍の減衰特性の劣化もなかった。

【００４５】従来構成と比較して良好な減衰特性が得られたのは、従来のセラミックパッケージを不要とすることにより、不要なインダクタンスが発生しないこと、及びセラミックパッケージがないために、幅が広い入出力端子電極が不要で、回路基板との導通接続するだけの入出力電極で済むため、入出力間電極の対向距離が広く、発生容量が小さくなること等が考えられる。

【００４６】また、本発明のチップ弾性表面波フィルタにおいては、図２に表示ｄ（対向間隔）で示す箇所において、入出力３ａと接地用電極３ｂの対向容量による特性劣化が懸念されるが、これについては全く問題がないことを確認した。この箇所の容量により変化するのは主としてＶＳＷＲ（定在波比）であり、ＶＳＷＲに変化がなければ減衰特性については全く問題はないことが判明した。

【００４７】図７は対向間隔ｄとその箇所に生じる容量Ｃの関係を示すグラフである。対向間隔ｄが２０μｍ以下になると急激に発生する容量が大きくなることを示している。ｄが２０μｍにおける容量は約０．１４ｐＦであるので、この場合のＶＳＷＲの変化は、図８に示すように高々０．０８であることがわかった。したがって、対向間隔ｄは２０μｍ以上あれば特性の劣化がないことが確認できた。

【００４８】

【発明の効果】本発明の弾性表面波装置によれば、圧電基板の側面が下面に対し鋭角に形成されているとともに、圧電基板の上面及び側面に保護膜が被着されているので、究極的に小型化，低背化が可能となり、特に圧電基板の側面を下面に対し４５°～８０°の最適角度とすることにより、圧電基板の破損を極力防止するとともに、保護膜を薄膜形成法にて均一に成膜することができる。

【００４９】さらに、保護膜として導電性である金属材料を用いることにより、保護膜の形成が容易である上

に、不要な電磁波等をシールドすることができ、しかも気密性を十分に確保することが可能な、製造容易で信頼性に優れた弾性表面波装置を提供することができる。

【図面の簡単な説明】

【図１】本発明に係る弾性表面波装置の実装構造を模式的に示す断面図である。

【図２】本発明に係る他の弾性表面波装置の電極構造を模式的に示す平面図である。

【図３】本発明に係る他の弾性表面波装置の実装構造を模式的に示す断面図である。

【図４】（ａ）～（ｃ）は、それぞれ本発明の弾性表面波装置の電気特性を説明する線図である。

【図５】（ａ）～（ｈ）は、それぞれ本発明の弾性表面波装置の製造工程を説明する断面図である。

【図６】（ｉ）～（ｍ）は、それぞれ本発明の弾性表面波装置の製造工程を説明する断面図である。

【図７】本発明の弾性表面波装置の対向間隔と容量との関係を示す線図である。

【図８】本発明の弾性表面波装置の対向容量とＶＳＷＲとの関係を示す線図である。

【図９】従来の弾性表面波フィルタを説明する図であり、（ａ）は封止していない状態の上視図、（ｂ）は下視図、（ｃ）は（ａ）のＡ－Ａ線拡大断面図である。

【図１０】（ａ）～（ｃ）は、それぞれ従来の弾性表面波フィルタの電気特性を説明する線図である。

【図１１】従来の他の弾性表面波フィルタを説明する図であり、（ａ）は封止していない状態の上視図、（ｂ）は下視図、（ｃ）は（ａ）のＢ－Ｂ線拡大断面図である。

【図１２】（ａ）～（ｃ）は、それぞれ従来の他の弾性表面波フィルタの電気特性を説明する線図である。

【符号の説明】

１，１’：チップ弾性表面波フィルタ（弾性表面波装置）

２：圧電基板

３：電極

３ａ：入出力電極

３ｂ：接地用電極

３ｃ：共振子電極（励振電極）

３ｄ：接続電極

４：電極保護膜

５：空間

６：回路基板

７：フォトレジスト

８：接着材

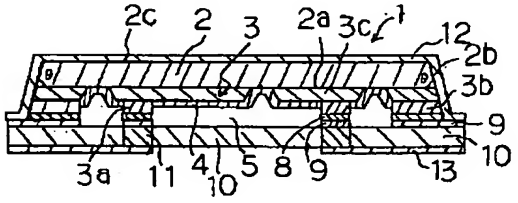
９：接続パッド

１０：フィルタ基板

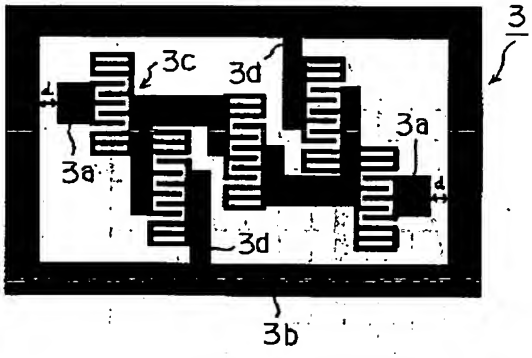
１１：ビア電極

１２：金属薄膜

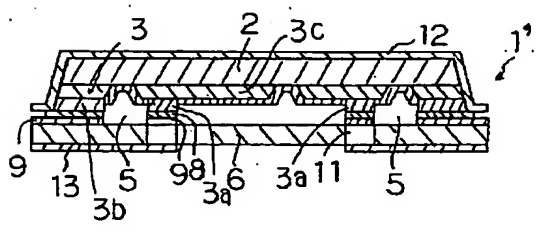
【図１】



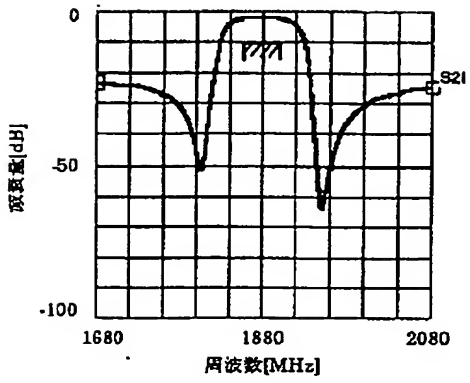
【図２】



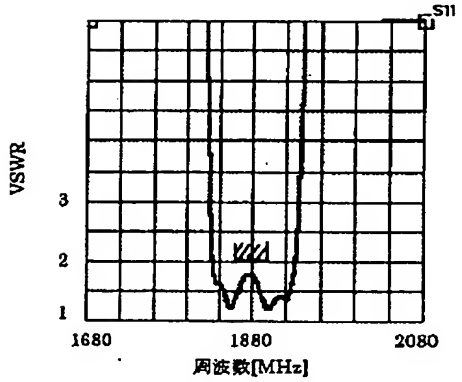
【図３】



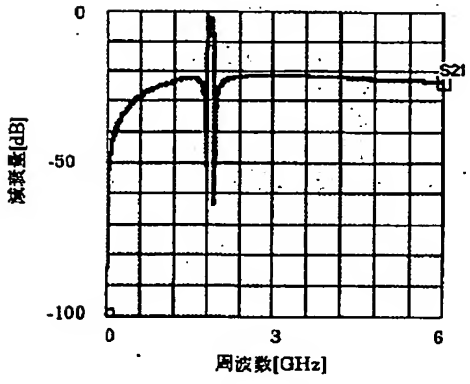
【図４】


0
-50
-100
減衰量[dB]
S21
1680
1880
2080
周波数[MHz]

(a)

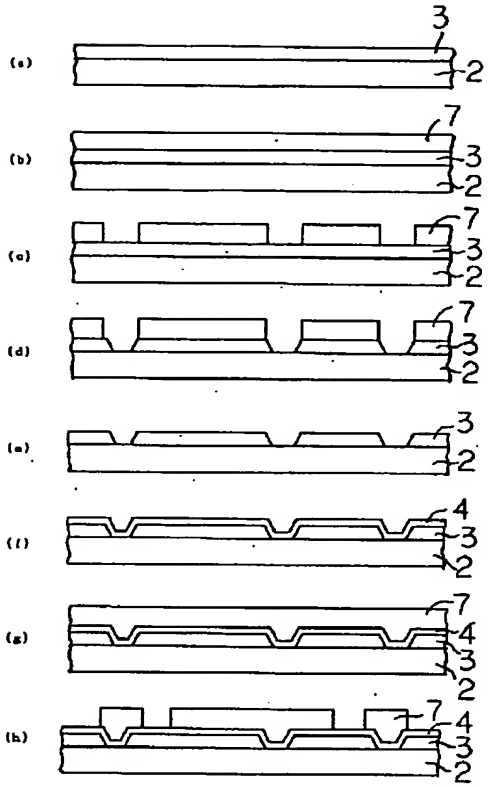

S11
VSWR
3
2
1
1680
1880
2080
周波数[MHz]

(b)

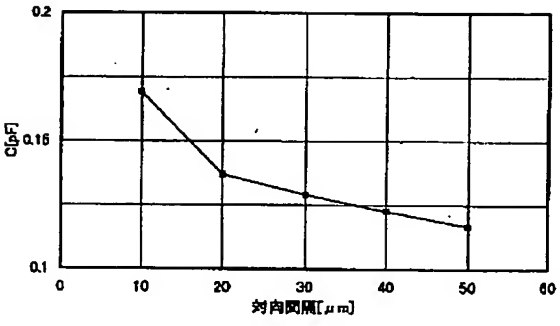

0
-50
-100
減衰量[dB]
S21
0
3
6
周波数[GHz]

(c)

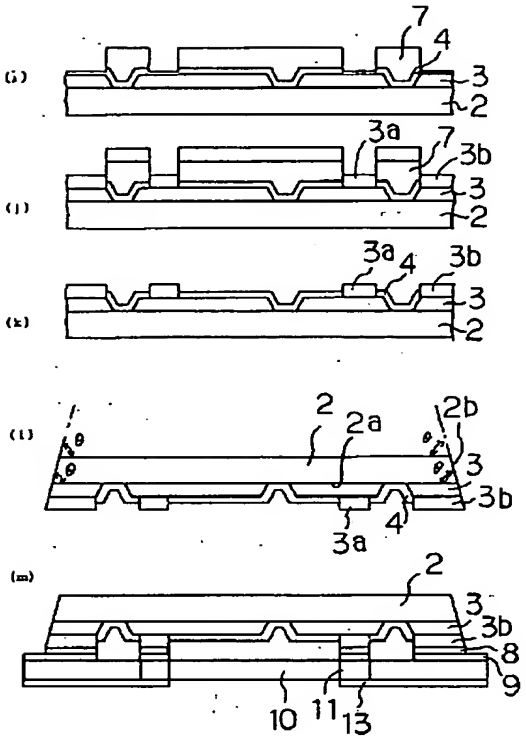
【図５】


(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
2
3
4
7

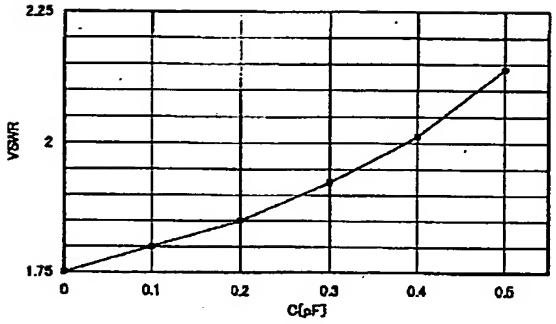
【図７】


0.2
0.15
0.1
C[pF]
0
10
20
30
40
50
60
対向間隔[μm]

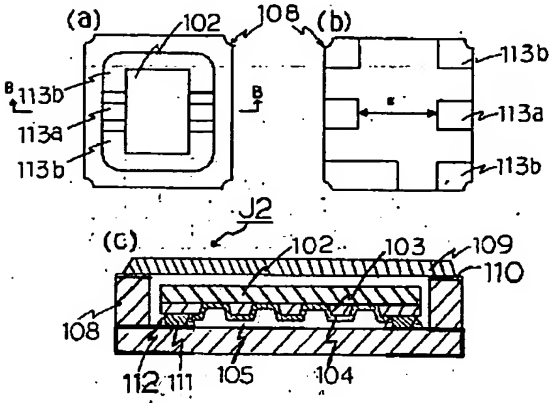
【図６】


(G)
7
4
3
2
(I)
3a
7
3b
3
2
(K)
3a
4
3b
3
2
(L)
θ
θ
2
2a
2b
3
3b
4
3a
(M)
2
3
3b
8
9
10
11
13

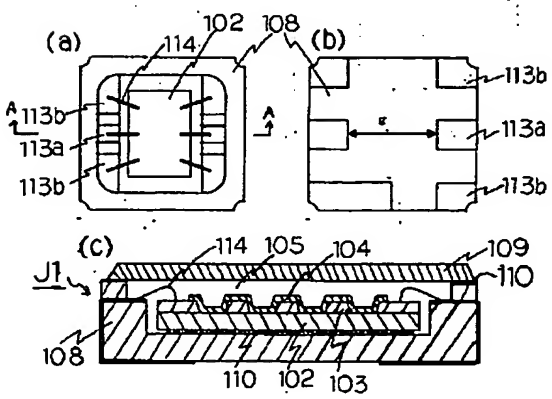
【図８】


2.25
2
1.75
VSWR
0
0.1
0.2
0.3
0.4
0.5
C[pF]

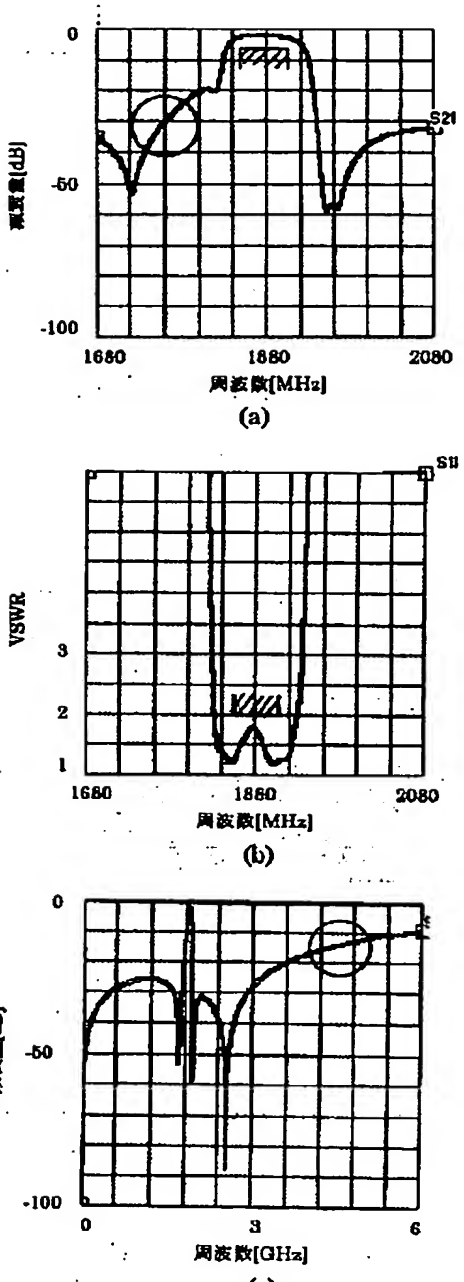
【図１１】


(a)
102
108
(b)
113b
A
113b
113a
113b
B
B
113b
113a
113b
J2
(c)
102
103
109
110
108
112
111
105
104

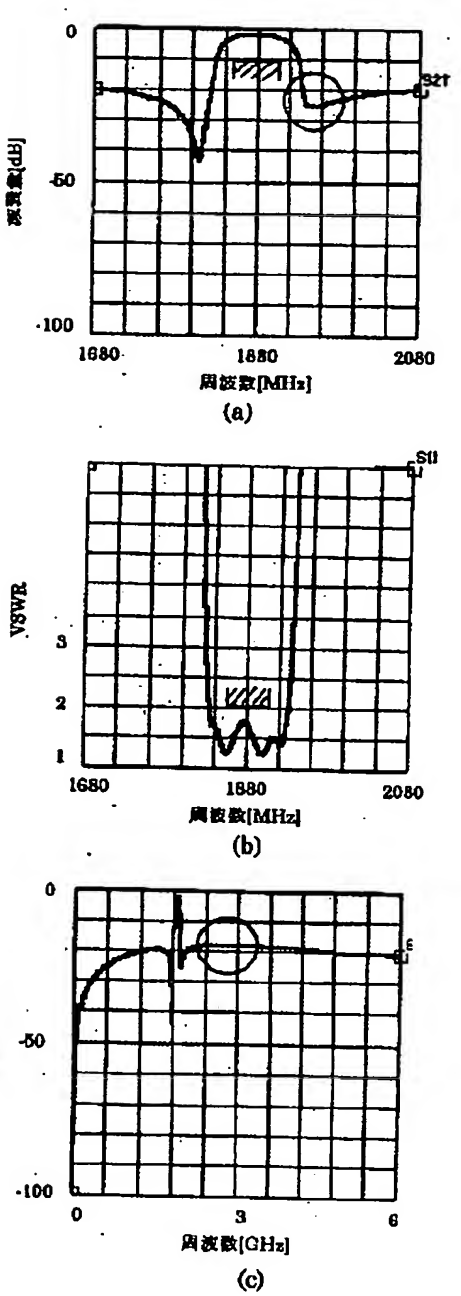
【図９】


(a)
114
102
108
(b)
A
113b
113a
113b
A
113b
113a
113b
(c)
J1
114
105
104
109
110
108
110
102
103

【図１０】


0
-50
-100
減衰量[dB]
S21
1680
1880
2080
周波数[MHz]
(a)
S11
VSWR
3
2
1
1680
1880
2080
周波数[MHz]
(b)
0
-50
-100
減衰量[dB]
0
3
6
周波数[GHz]
(c)

【図１２】


0
-50
-100
減衰量[dB]
S21
1680
1880
2080
周波数[MHz]
(a)
S11
VSWR
3
2
1
1680
1880
2080
周波数[MHz]
(b)
0
-50
-100
減衰量[dB]
0
3
6
周波数[GHz]
(c)

CLAIMS

[Claim(s)]

[Claim 1] Surface acoustic wave equipment which is surface acoustic wave equipment which was made to mount the underside side of the piezo-electric substrate in which the excitation electrode was formed, on the circuit board, and is characterized by carrying out covering formation of the protective coat on the top face and side face of this piezo-electric substrate while forming the side face of said piezo-electric substrate in an acute angle to an underside.

[Claim 2] Surface acoustic wave equipment according to claim 1 characterized by forming the side face of said piezo-electric substrate in 45 degrees - 80 degrees to an underside.

[Claim 3] Surface acoustic wave equipment according to claim 1 characterized by said protective coat being conductivity.

[Translation done.]

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is used for mobile communication equipment, such as a cellular phone, and relates to surface acoustic wave equipments, such as a surface acoustic wave filter and a duplexer.

[0002]

[Description of the Prior Art] To be low weight and the low back by the low component-side product are desired by the limit for the miniaturization of the cellular-phone terminal with which the surface acoustic wave filter used for current and mobile communication equipment intensifies.

[0003] Conventionally, the surface acoustic wave filter J1 shown in drawing 9 (a) - (c) consists of the substrate 102 which consists of the piezoelectric single crystal with which the excitation electrode was mainly formed, and the ceramic package 108 which carries out closure mounting of it.

[0004] The surface acoustic wave resonator electrode (excitation electrode) 103, the I/O electrodes 113a and 113b, the grand electrodes (not shown), and those connection electrodes of the shape of a ctenidium which changes from aluminum, an aluminum-copper alloy, etc. to a substrate 102 are formed in the same field.

[0005] In the excitation electrode 103, the protective coat 104 is formed in the top face, and adhesion and corrosion of a foreign matter, such as a contaminant, are prevented. A substrate 102 is fixed to the pars basilaris ossis occipitalis of a ceramic package 108 with resin 110, and flow connection of I/O electrode 103a on a substrate 102 and the grand electrode (not shown) is made to the

input/output terminal electrodes 113a and 113b of a ceramic package 108 using the wire 114, respectively.

[0006] A protective coat is not formed in the part which connects a wire 114 for stability reservation of connection. Since a substrate 102 is an elastic body, the space 105 which secures free vibration is required for it. For this reason, a lid 109 is formed in the upper part, and the hermetic seal is carried out with a ceramic package 108 and resin 110 so that oscillating damping by moisture and moisture entering from the exterior may be prevented. In the case of a tetraboric-acid lithium single crystal etc., since there is deliquescence, especially as for encroachment of moisture etc., a piezo-electric substrate poses a serious problem in respect of dependability etc.

[0007] In such a surface acoustic wave filter, the wire 114 is performing electrical installation of a substrate 102 and a ceramic package 108, and height at this rate had become the hindrance of a miniaturization. Moreover, the ceramic package 108 was dramatically large compared with the substrate 102, for example, was enlarged no less than about 1.5-2.1mm per side, and if it resulted in the area of base, it had increased also about 3 times.

[0008] Furthermore, since grand terminal electrode 113b of the ceramic package 108 interior was connected to the rear face of a ceramic package 108 through the end-face grand electrode with narrow width of face as shown in drawing 9 (c) as shown in drawing 9 (a), the inductor component had occurred, and as a round part showed to drawing 10 , the damping property in 4-6GHz had deteriorated the low frequency side of a passband (hatching part).

[0009] Moreover, the surface acoustic wave filter J2 as shown in drawing 11 (a) - (c) connects I/O electrode 103a on a substrate 102, and a grand electrode (not shown) to the terminal electrodes 113a and 113b on a ceramic package 108 through the metal bump 111, and in order to compensate the lowness of the connection resilience of a bump 111 and the terminal electrodes 113a and 113b, it is reinforcing with conductive resin 112. Moreover, conductive resin 112 is also bearing the duty which absorbs the badness of a bump's 111 display flatness.

According to the above structure, only the part of the loop-formation height of a wire can attain low back-ization.

[0010] However, when the area of base of a ceramic package 108 becomes small, the spacing g of input/output terminal electrode 113a on the back became narrow, and capacity has occurred in inter-electrode [this]. For this reason, as a round part showed to drawing 12 , the about 3GHz damping property had deteriorated the RF side of a passband (hatching part). Moreover, the ceramic package 108 occupied most filter configurations, and had still become the hindrance of small, a light weight, and the reduction in the back.

[0011] Then, this invention aims at offering the surface acoustic wave equipment which could be miniaturized ultimately and was excellent in dependability, without spoiling a damping property.

[0012]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the surface acoustic wave equipment of this invention is surface acoustic wave equipment which turns down the 1 principal-plane side of the piezo-electric substrate in which the excitation electrode was formed, and was made to mount on the circuit board, and it is characterized by putting the protective coat on the other principal plane side of this piezo-electric substrate, and the side face while the side face of a piezo-electric substrate is formed in the acute angle to said circuit board. Moreover, it is good for the side face of a piezo-electric substrate to form in 45 degrees - 80 degrees to the circuit board suitably, and further, if a protective coat consists of conductive film, such as a metal, outside ****** (higher harmonic etc.) can be shielded suitably.

[0013]

[Embodiment of the Invention] Below, the operation gestalt of the surface acoustic wave equipment concerning this invention is explained at a detail based on a drawing.

[0014] The sectional view of the mounting structure of the surface acoustic wave filter 1 is shown in drawing 1 , and the electrode structure is shown in drawing 2

as surface acoustic wave equipment. As for the surface acoustic wave filter 1, the electrodes 3, such as an excitation electrode, are formed in underside 2a of the piezo-electric substrates 2, such as a lithium tantalate single crystal, a single crystal (for example, lanthanum-gallium-niobium system single crystal) which has a langasite mold crystal structure, and a tetraboric-acid lithium single crystal. That is, the plurality of resonator electrode 3c of the shape of a ctenidium which is the excitation electrode which carries out a postscript is connected to underside 2a of the piezo-electric substrate 2 for example, in the ladder mold circuit, and the electrode protective coat 4 half-conductive [, such as silicon and silicon oxide,] or insulating is formed on 3d of the connection electrode, I/O electrode 3a, and electrode 3b for touch-down. Moreover, to top-face 2c of the piezo-electric substrate 2, and side-face 2b, covering formation of the metal thin film 12 which is a conductive protective coat was carried out by the thin film forming method, and the chip surface acoustic wave filter of the structure which is rich in weatherability is realized.

[0015] Although it is desirable that it is conductivity here as for the protective coat formed in the top face and side face of the piezo-electric substrate 2 in order to shield outside ****** (higher harmonic etc.), it is good to consider as a metal, when airtightness can be secured further and membrane formation is made simple and easy. After detaching a chip surface acoustic wave filter in dicing separately in forming the metal thin film 12, one or more sorts of metals which consist of aluminum, Au, Ti, Cr, etc. with vacuum deposition are formed, or the laminated structure of aluminum film and Cu film, the laminated structure of W film and Au film, etc. are formed.

[0016] Although it is necessary to also make the side face of the piezo-electric substrate 2 separated by dicing constitute the metal thin film 12 from moderate thickness, it is simplest to perform this membrane formation with vacuum deposition. Since a vacuum evaporationo particle is mostly formed perpendicularly to a vapor-deposited field at this time, when the side face of the piezo-electric substrate 2 is vertical, uniform membrane formation is difficult.

[0017] So, in this invention, in case a chip surface acoustic wave filter is separately separated in dicing, while the configuration of the gear tooth of dicing uses a convex (the shape of for example, V character) thing and forms a taper in a component edge, it separates. And the metal thin film 12 of 500A - 10 micrometers of thickness is formed in the top face and side face of the piezo-electric substrate 2. It is because compressive stress will occur at low temperature, a tensile stress will occur at an elevated temperature according to the difference of the coefficient of linear expansion of the metal thin film 12 and the piezo-electric substrate 2 and it will have an adverse effect on the temperature characteristic, if membrane formation becomes difficult in a side face, a top-face edge, etc. of the piezo-electric substrate 2, and reliance cannot be maintained at weatherability, if having made thickness into the above-mentioned range considers as less than 500A here, but it exceeds 10 micrometers.

[0018] Moreover, 45 - 80 degrees of the include angle (taper angle) theta of underside 2a of the piezo-electric substrate 2 and side-face 2b which were specified by drawing 1 and drawing 6 (I) to accomplish are best. If, as for this reason, a taper angle exceeds 80 degrees, vacuum evaporationo material will not be formed by homogeneity on the side face of the piezo-electric substrate 2. Moreover, it is because a crack and KAKE will occur in the piezo-electric substrate 2 and it will have an adverse effect on propagation of a surface acoustic wave, in case the side face of the piezo-electric substrate 2 becomes sharp and a chip is laid if a taper angle is less than 45 degrees.

[0019] The surface acoustic wave filter 1 constituted as mentioned above forms in the underside side of the piezo-electric substrate 2, or a side face electrode 3b for touch-down which encloses resonator electrode 3c, and mounts it on the circuit board 6. And between [h] the front face of the circuit board 6 and the front faces of resonator electrode 3c is set as the distance more than the wavelength of a surface acoustic wave.

[0020] In addition, in drawing 1 , 8 is a conductive binder which consists of

conductive resin etc., 9 is a connection pad which consists of the metal formed on the filter base plate 10, 11 is a beer electrode and 13 is an external ejection electrode. And it is made to mount the surface acoustic wave filter 1 constituted in this way in an external circuit substrate. Moreover, as shown in drawing 3 , surface acoustic wave filter 1' (the surface acoustic wave filter 1 and a configuration except having used the circuit board 6 instead of the filter substrate 10 are the same) which was made to carry out face down mounting of the underside 2a side of the piezo-electric substrate 2 may be directly constituted instead of the filter substrate 10 of drawing 1 in the circuit board 6 which consists of glass epoxy etc.

[0021] Here, since I/O electrode 3a and electrode 3b for touch-down are formed in the same process, these electrodes are excellent in display flatness. Moreover, since the I/O electrode and the electrode for touch-down project rather than the electrode protective coat 4 which consists of half-conductivity or insulation, the space 5 for free vibration can be maintained and it is possible to mount by face down to the filter substrate 10 or the circuit board 6 as it is. Moreover, since electrode 3b for touch-down is formed in the perimeter enclosure of a substrate 2, airtightness is also secured.

[0022] Moreover, since the metal thin film is formed in the top face and side face of a piezo-electric substrate of a chip surface acoustic wave filter, cutoff of the unnecessary electromagnetic wave in RF (Radio Frequency) block is possible.

[0023] In addition, although this invention explained the ladder mold filter, it can carry out by changing suitably in the range which does not deviate from the summary of this invention that what is necessary is just what has an excitation electrode also with surface acoustic wave equipments, such as duplexers other than the filter and filter of a resonator mold or a propagation mold.

[0024]

[Example] The concrete example which produced the chip surface acoustic wave filter concerning this invention hereafter is explained.

[0025] Drawing 5 (a) - (h) and drawing 6 (i) - (m) is the typical sectional view

showing the manufacture process of a chip surface acoustic wave filter, respectively. In addition, photolithography was carried out to manufacture using a stepper (reduced-projection-exposure machine) and RIE (Reactive Ion Etching) equipment.

[0026] (1) First, ultrasonic cleaning was performed for the substrate 2 (42 degreeY cut of a lithium tantalate single crystal) using an acetone, IPA, etc., and the organic component was removed. Next, after clean oven fully performed substrate desiccation, the electrode 3 was formed as shown in drawing 5 (a). The sputtering system was used for membrane formation of an electrode 3, and the electrode 3 which consists of an aluminum-Cu (2 % of the weight) alloy was formed. This electrode layer thickness could be about 2000A.

[0027] (2) As shown in drawing 5 (b), the photoresist 7 was applied to the thickness of about 0.5 micrometers with the spin coat.

[0028] (3) As shown in drawing 5 (c), the stepper performed pattern NINGU in the request configuration, the photoresist 7 of a garbage was dissolved with the alkali developer with the developer, and the request resist pattern was formed.

[0029] (4) As shown in drawing 5 (d), the electrode 3 was etched into the request pattern with the RIE system.

[0030] (5) As shown in drawing 5 (e), the photoresist 7 was exfoliated and pattern NINGU was ended.

[0031] (6) it is shown in drawing 5 (f) -- as -- SiO2 from -- the electrode protective coat 4 which changes was formed in thickness of 250A with the sputtering system.

[0032] (7) As shown in drawing 5 (g), the photoresist 7 was again applied to the whole surface by the thickness of about 3 micrometers.

[0033] (8) As shown in drawing 5 (h), a part of photoresist 7 of the substrate 2 which forms I/O electrode 3a and electrode 3b for touch-down was exposed, and it deleted.

[0034] (9) SiO2 of the substrate 2 which forms I/O electrode 3a and electrode 3b for touch-down as shown in drawing 6 (i) CDE removed the electrode protective

coat 4.

[0035] (10) As shown in drawing 6 (j), aluminum electrode was formed with vacuum deposition in thickness of 2 micrometers so that it might become thicker than the electrode protective coat 4.

[0036] (11) As shown in drawing 6 (k), the lift off removed the electrode material on a photoresist with the photoresist 7. .

[0037] (12) As shown in drawing 6 (l), the dicing of the wafer was carried out using the gear tooth of a V character mold along the dicing line, and it divided so that the taper angle theta of a chip edge might become 45 degrees - 80 degrees, and the chip was completed.

[0038] Next, mounting is explained.

[0039] (13) As shown in drawing 6 (m), face down mounting of the above-mentioned chip was carried out at the filter substrate 10, and the electrode on a substrate was connected for I/O electrode 3a and grand electrode 3b with conductive resin (not shown).

[0040] (14) As shown in drawing 1 , aluminum was formed in top-face 2c of the piezo-electric substrate 2, and side-face 2b the thickness of 1000A by vacuum evaporationo.

[0041] (15) Finally, the filter base plate 10 was aligned with the chip, dicing divided into the piece of an individual, and each filter 1 was completed.

[0042] 90 - 93 % of the weight, the reactivity polyester system resin made to contain 81 to 86% of the weight, or epoxy system resin was applied to the periphery and I/O polar zone of electrode 3b for touch-down for the silver filler with screen printing at the above-mentioned mounting, and temporary hardening of 80 degrees C and about 1 hour was performed, and, subsequently it once mounted by making it harden in 120-225 degrees C and 10 - 60 minutes.

[0043] according to the mounting structure of the above-mentioned surface acoustic wave filter -- metal material -- the piezo-electric substrate periphery section -- surrounding -- **** -- moreover, the perimeter of a substrate 2 -- electrode 3b for touch-down -- taking -- ****** -- since it was made like,

airtightness was also simultaneously securable. Moreover, since I/O electrode 3a and electrode 3b for touch-down are formed in the same process, they are excellent in display flatness and can make flow dependability very high. Moreover, the height of space 5 is secured to about 2 micrometers, that of this height is almost equivalent to the wavelength in a surface acoustic wave center of filter frequency, and if there is space height beyond this, it will not bar an oscillation of a surface acoustic wave.

[0044] Thus, as shown in drawing 3 , the electrical property of the obtained chip surface acoustic wave filter does not have degradation of the damping property produced conventionally, and was able to acquire the good damping property. Rather than a passband (hatching part), the magnitude of attenuation 20dB or more could be obtained, and, moreover, there was also no degradation of the damping property near the passband at a RF side.

[0045] Since there are not an unnecessary inductance's not occurring by making the conventional ceramic package unnecessary and a ceramic package, that the good damping property was conventionally acquired as compared with the configuration has an unnecessary input/output terminal electrode with wide width of face, since [with the circuit board] it ends with the I/O electrode which makes flow connection, its opposite distance of the electrode between I/O is large, and it can consider that generating capacity becomes small etc.

[0046] Moreover, in the chip surface acoustic wave filter of this invention, in the part shown in drawing 2 by Display d (opposite spacing), although we were anxious about property degradation by the opposite capacity of I/O 3a and electrode 3b for touch-down, about this, it checked that it was completely satisfactory. VSWR (standing-wave ratio) mainly changed with the capacity of this part, and when there was no change in VSWR, about the damping property, it completely became clear that it was satisfactory.

[0047] Drawing 7 is a graph which shows the relation between the opposite spacing d and the capacity C produced in the part. If the opposite spacing d is set to 20 micrometers or less, it is shown that the capacity generated rapidly

becomes large. since capacity [in / in d / 20 micrometers] is about 0.14pF, change of VSWR in this case is shown in drawing 8 -- as -- at most -- it turned out that it is 0.08. Therefore, it has checked that it would not have degradation of a property if there are 20 micrometers or more of opposite spacing d.

[0048]

[Effect of the Invention] While the side face of a piezo-electric substrate is formed in the acute angle to the underside according to the surface acoustic wave equipment of this invention Since the protective coat is put on the top face and side face of a piezo-electric substrate, while preventing breakage of a piezo-electric substrate as much as possible by attaining a miniaturization and low back-ization ultimately, especially making the side face of a piezo-electric substrate into the optimal include angle of 45 degrees - 80 degrees to an underside A protective coat can be formed to homogeneity by the thin film forming method.

[0049] furthermore, the manufacture which an unnecessary electromagnetic wave etc. can be shielded to the top where formation of a protective coat is easy, and can moreover fully secure airtightness in it by using the metallic material which is conductivity as a protective coat -- it is easy and surface acoustic wave equipment excellent in dependability can be offered.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view showing typically the mounting structure of the surface acoustic wave equipment concerning this invention.

[Drawing 2] It is the top view showing typically the electrode structure of other surface acoustic wave equipments concerning this invention.

[Drawing 3] It is the sectional view showing typically the mounting structure of other surface acoustic wave equipments concerning this invention.

[Drawing 4] (a) - (c) is a diagram which explains the electrical property of the surface acoustic wave equipment of this invention, respectively.

[Drawing 5] (a) - (h) is a sectional view which explains the production process of the surface acoustic wave equipment of this invention, respectively.

[Drawing 6] (i) - (m) is a sectional view which explains the production process of the surface acoustic wave equipment of this invention, respectively.

[Drawing 7] It is the diagram showing the relation between opposite spacing of the surface acoustic wave equipment of this invention, and capacity.

[Drawing 8] It is the diagram showing the relation between the opposite capacity of the surface acoustic wave equipment of this invention, and VSWR.

[Drawing 9] It is drawing explaining the conventional surface acoustic wave filter, and a lower ** Fig. and (c of top-view drawing in the condition that (a) is not closing, and (b)) are the A-A line expanded sectional views of (a).

[Drawing 10] (a) - (c) is a diagram explaining the electrical property of the surface acoustic wave filter of the ******** former.

[Drawing 11] It is drawing explaining other conventional surface acoustic wave filters, and a lower ** Fig. and (c of top-view drawing in the condition that (a) is not closing, and (b)) are the B-B line expanded sectional views of (a).

[Drawing 12] (a) - (c) is a diagram explaining the electrical property of other surface acoustic wave filters of the ******** former.

[Description of Notations]

1 1': Chip surface acoustic wave filter (surface acoustic wave equipment)

2: A piezo-electric substrate

3: Electrode

3a: I/O electrode

3b: The electrode for touch-down

3c: Resonator electrode (excitation electrode)

3d: Connection electrode

4: Electrode protective coat

5: Space

6: Circuit board

7: Photoresist

8: Binder

9: Connection pad

10: Filter substrate

11: Beer electrode

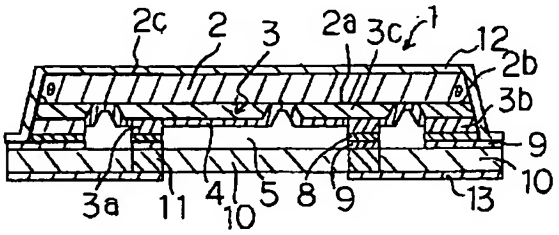
12: Metal thin film

[Translation done.]

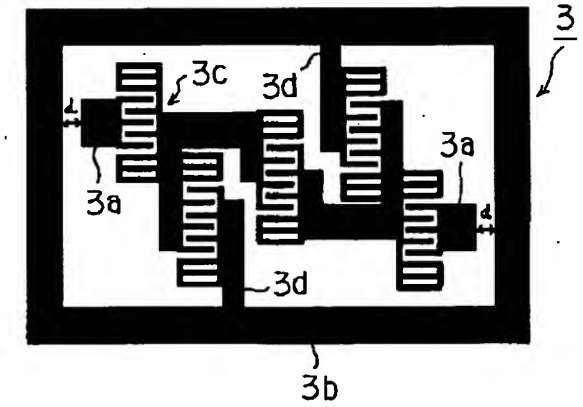
* NOTICES *

DRAWINGS

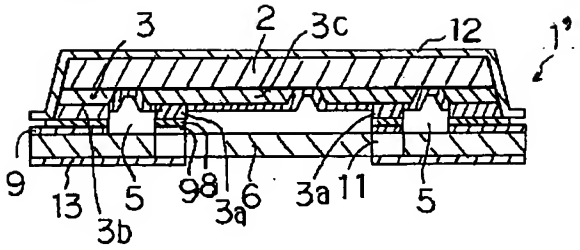
[Drawing 1]



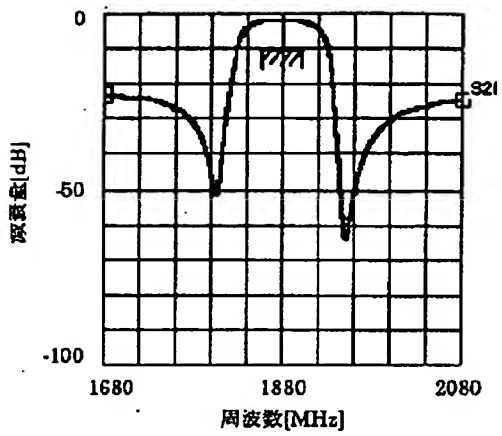
[Drawing 2]



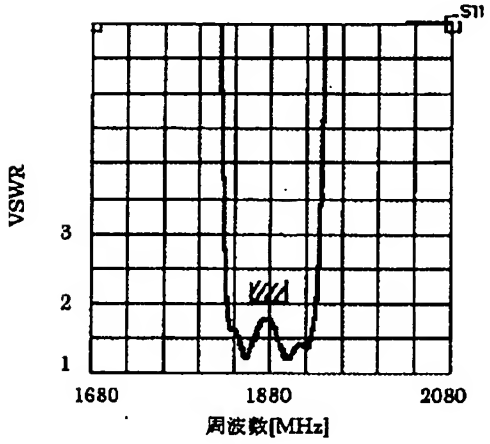
[Drawing 3]



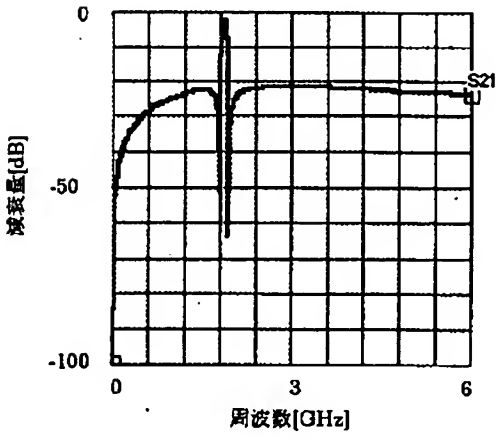
[Drawing 4]



(a)

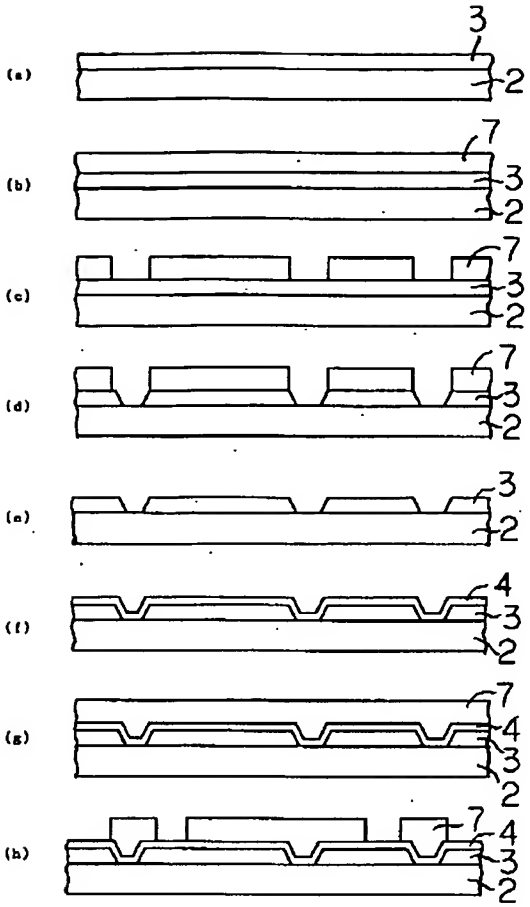


(b)

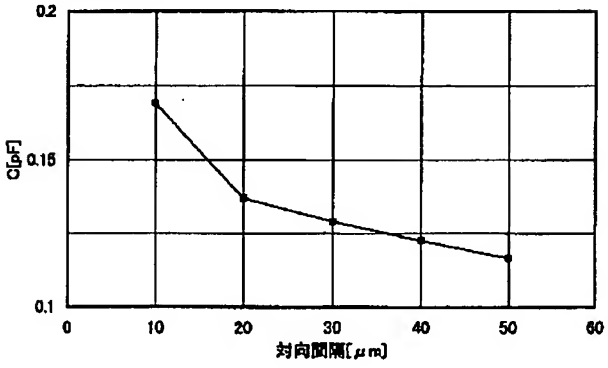


(c)

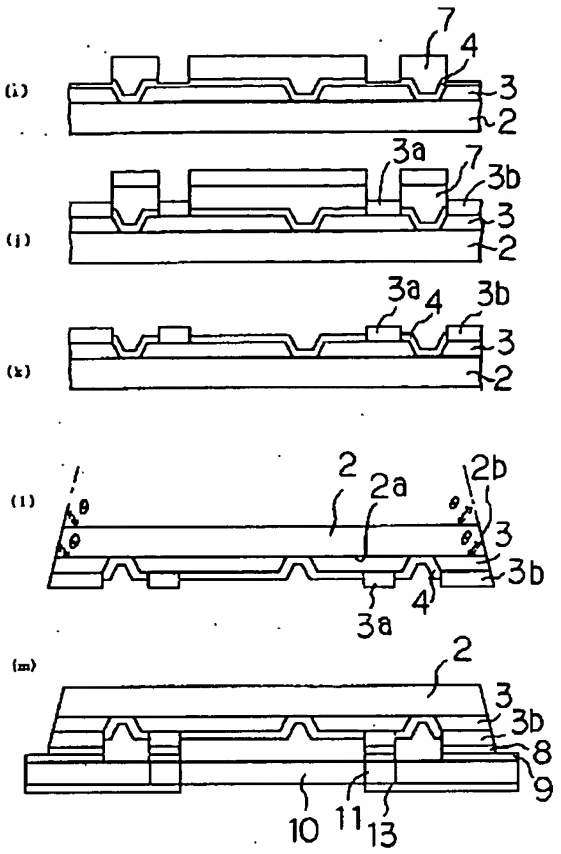
[Drawing 5]



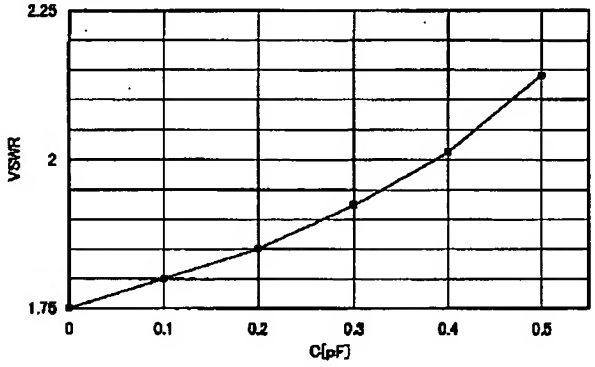
[Drawing 7]



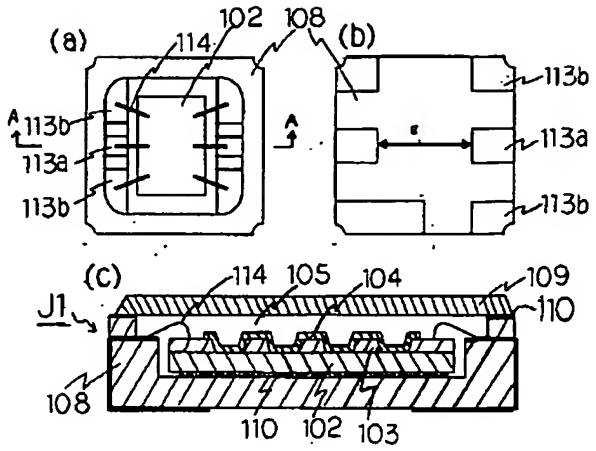
[Drawing 6]



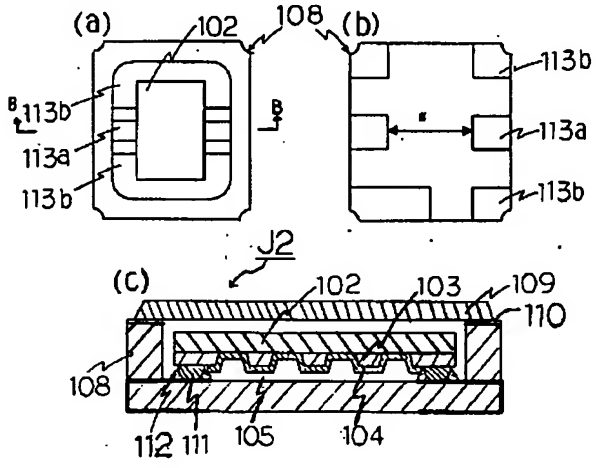
[Drawing 8]



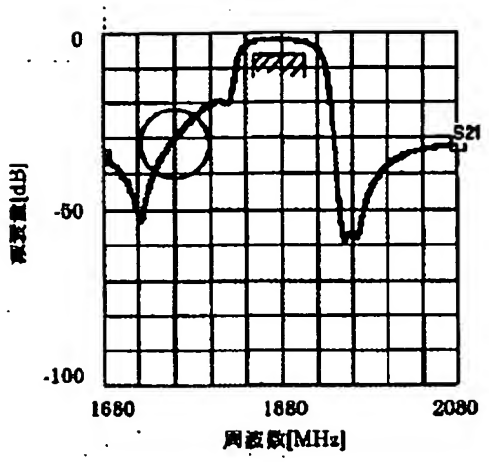
[Drawing 9]



[Drawing 11]



[Drawing 10]



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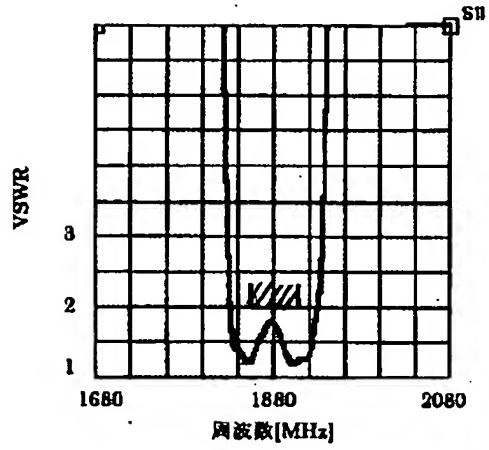

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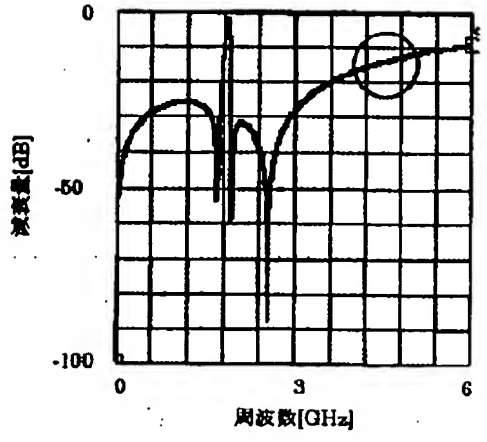
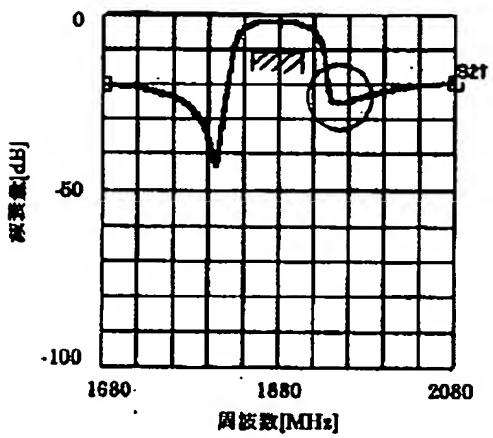
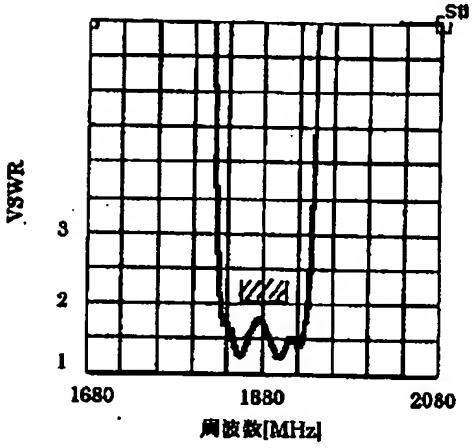


(c)

[Drawing 12]



(a)



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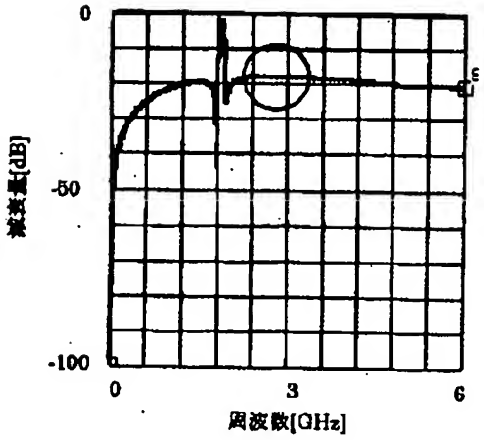

(c)

[Translation done.]